TECHNICAL MEMORANDUM

Tenmile Lakes Toxic Algae Monitoring for July 19, 2010

Prepared for: **Tenmile Lakes Basin Partnership**

Pepared by: **Jacob Kann, Ph.D.**

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July 19, 2010 toxic algal cell count results for Tenmile Lakes are as follows (see Figure 1 below for sample station location):

Station	Date	*Microcystis* (cells/ml)	*Gloeotrichia* (cells/ml)	Total *Microcystis*+ *Gloeotrichia*	Total *Anabaena* (cells/ml)
S3	7/19/2010	0	0	0	918
S8	7/19/2010	0	0	0	703
N11	7/19/2010	0	0	0	237
N16	7/19/2010	285	0	285	370

*Exceeds World Health Organization Alert Level 1 increased vigilance guideline level of 500 cells ml^{-1} for potentially toxigenic species in drinking water systems.

**Exceeds World Health Organization Alert Level 2 public health posting guideline level of 2000 cells ml^{-1} for potentially toxigenic species in drinking water systems

***Exceeds State of Oregon Recreational Guideline Levels of 40,000 cells/ml for *Microcystis* or 100,000 cell/ml for *Anabaena*

Samples from July 19th show that total *Anabaena* cell density at the standard South Lake stations S3 and S8 exceeded the WHO Alert Level 1 guideline for potentially toxigenic species (Table 1; Figure 2). Station N16 showed a M*icrocystis aeruginosa* (MSAE) cell density of 285 cells/ml which does not exceed the guideline level of 500 cells/ml. The predominant *Anabaena* species identified was *Anabaena planctonica* (Appendix I), a species less commonly associated with toxin production. Given cell densities below the public health posting guideline of 2000 cells/ml, no action other than continued monitoring is warranted at this time.

Biovolume at stations S3, S8 and N11 was comprised primarily of the cyanobacterium (blue-green) *Aphanizomenon flos-aquae* and secondarily of the diatom *Fragilaria* crotonensis. Station N16 was also comprised primarily of *Aphanizomenon flos-aquae*, but secondarily of *Anabaena planctonica* (see attached data sheets below). Although the blue-green alga *Aphanizomenon flos-aquae* was present at all stations and achieved a cell density of 55,000 cells/ml at S8, this species has not demonstrated toxin production in Oregon.

Because reported levels for non-dominant species indicate the general trend but can not guarantee that levels of potentially toxigenic species at a particular location do not exceed guideline values, and the fact that cyanobacterial cells have been reported in home-owner drinking water treatment systems (see Kann 2007), all drinking water protection efforts should be in place. Levels of all potentially toxic cyanobacteria were well below recreational guidelines.

Due to the patchy nature of blue-green algal blooms it is possible for higher Microcystis aeruginosa and Anabaena densities (and therefore higher microcystin toxin and anatoxin concentrations to be present in areas not sampled in this survey, particularly along shorelines or during calm conditions of little to no wind. Given the

lakes' demonstrated history of toxic blooms, and the fact that all areas of the lake cannot be tested at all times, those utilizing the lake for drinking water should always follow Oregon Health Division recommendations for purification (attached). In addition, recreational users should always avoid contact with water whenever noticeable surface concentrations of algae are evident or when the lake has an obvious green to blue-green appearance. Moreover, because pets or other domestic animals are the most likely to ingest contaminated water, these animals should not be allowed access to the lakeshore whenever either noticeable surface concentrations of algae or an obvious green to blue-green appearance is evident.

References for Alert Levels

Kann, J. 2007. Tenmile Lakes Toxic Algal Sampling Program: 2006 Data Summary Report. Tenmile Lakes Basin Partnership, Lakeside OR 97520

Falconer et al. 1999. Safe levels and safe practices. Pages 155-177 *in*: I. Chorus and J. Bartram, editors. *Toxic Cyanobacteria in water: a guide to their public health consequences*. World Health Organization Report. E & FN Spon, London and New York.

Stone, D., and W. Bress. 2007. Addressing Public Health Risks for Cyanobacteria in Recreational Freshwaters: The Oregon and Vermont Framework. Integrated Environmental Assesment and Managment; 3(1): 137 - 143 (2007). http://www.oregon.gov/DHS/ph/hab/docs/Stone_cyano_rec.pdf

Yoo, S.R., W.W. Carmichael, R.C. Hoehn, and S.E. Hrudy. 1995. Cyanobacterial (blue-green algal) toxins: a resource guide. AWWA Research Foundation and American Water Works Association. Denver, CO. 229 p. (ISBN 0-89867-824-2)

Year 2010 Tenmile Lakes Sample Site Locations

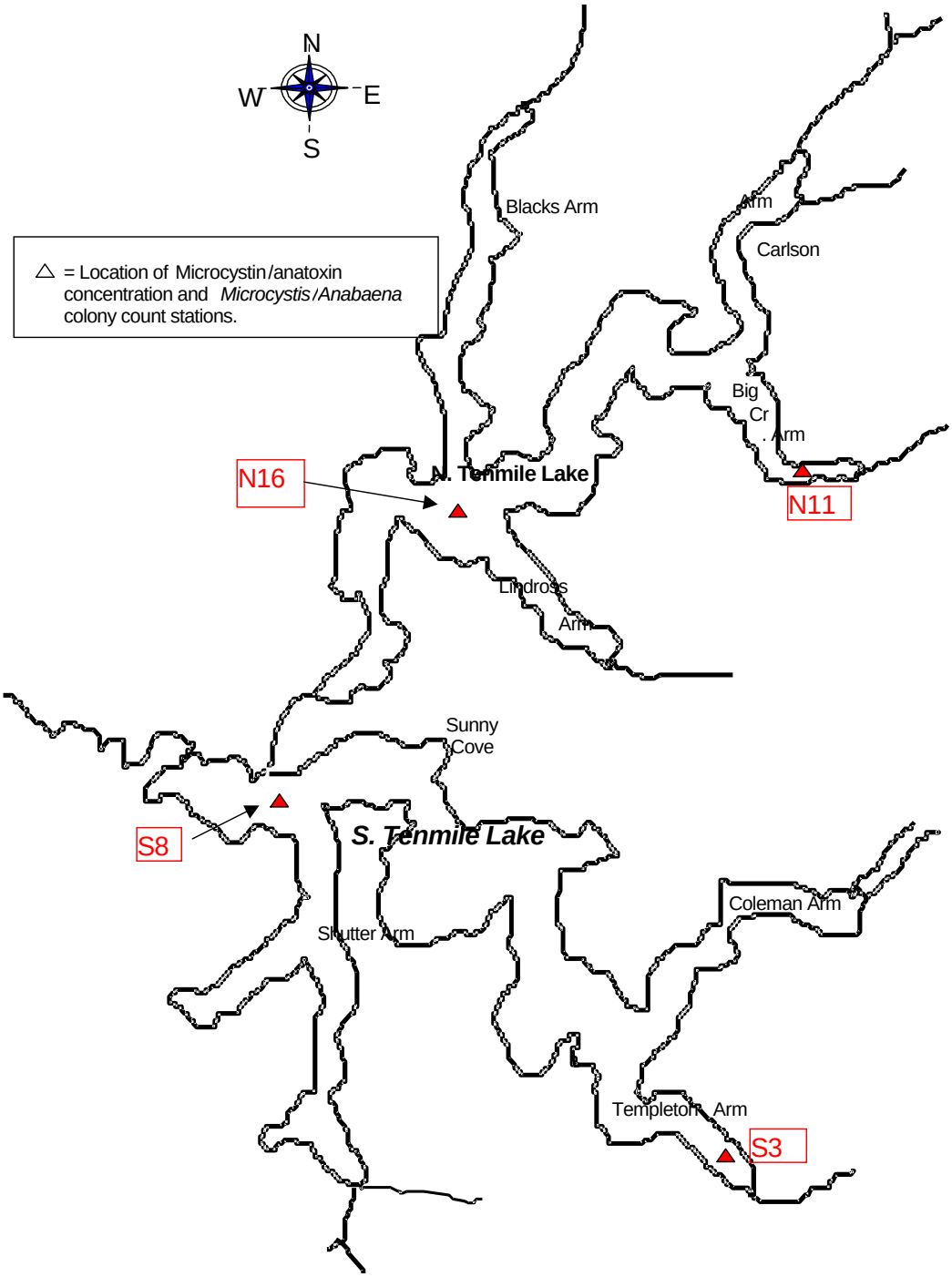

Figure 1. Tenmile Lakes 2010 Sampling Locations.

Appendix I: Aquatic Analysts Phytoplankton Lab Sheets

Phytoplankton Sample Analysis

Sample:	Tenmile Lake
Sample Site:	S3
Sample Depth:	
Sample Date:	19-Jul-10
Total Density (#/mL):	929
Total Biovolume (um^3/mL):	1,731,992
Trophic State Index:	53.8

	Species	Density #/mL	Density Percent	Biovolume um^3/mL	Biovolume Percent	Group
1	Aphanizomenon flos-aquae	838	90.2	1,214,272	70.1	bluegreen
2	Anabaena planctonica	27	2.9	161,023	9.3	bluegreen
3	Fragilaria crotonensis	27	2.9	335,965	19.4	diatom
4	Asterionella formosa	11	1.2	5,782	0.3	diatom
5	Synedra radians	8	0.8	2,743	0.2	diatom
6	Achnanthes minutissima	4	0.4	190	0.0	diatom
7	Synedra ulna	4	0.4	7,580	0.4	diatom
8	Navicula cryptocephala veneta	4	0.4	362	0.0	diatom
9	Melosira granulata	4	0.4	2,095	0.1	diatom
10	Cryptomonas erosa	4	0.4	1,981	0.1	cryptophyte

Aphanizomenon flos-aquae cells/mL =	19,274
Aphanizomenon flos-aquae heterocysts/mL =	293
Anabaena planctonica cells/mL =	880
Anabaena planctonica heterocysts/mL =	38

Aquatic Analysts **Sample ID:** NB84

Phytoplankton Sample Analysis

Sample:	Tenmile Lake
Sample Site:	S8
Sample Depth:	
Sample Date:	19-Jul-10
Total Density (#/mL):	2,391
Total Biovolume (um^3/mL):	3,856,012
Trophic State Index:	59.6

	Species	Density #/mL	Density Percent	Biovolume um^3/mL	Biovolume Percent	Group
1	Aphanizomenon flos-aquae	2,292	95.8	3,465,000	89.9	bluegreen
2	Fragilaria crotonensis	31	1.3	248,967	6.5	diatom
3	Cryptomonas erosa	23	1.0	11,917	0.3	cryptophyte
4	Anabaena planctonica	23	1.0	125,813	3.3	bluegreen
5	Chrysosphaerella sp.	15	0.6	1,833	0.0	chrysophyte
6	Chlamydomonas sp.	8	0.3	2,483	0.1	green

Aphanizomenon flos-aquae cells/mL =	55,000
Aphanizomenon flos-aquae heterocysts/mL =	420
Anabaena planctonica cells/mL =	688
Anabaena planctonica heterocysts/mL =	15

Aquatic Analysts **Sample ID:** NB85

Phytoplankton Sample Analysis

Sample:	Tenmile Lake
Sample Site:	N11
Sample Depth:	
Sample Date:	19-Jul-10
Total Density (#/mL):	1,619
Total Biovolume (um^3/mL):	2,314,610
Trophic State Index:	55.9

	Species	Density #/mL	Density Percent	Biovolume um^3/mL	Biovolume Percent	Group
1	Aphanizomenon flos-aquae	1,542	95.2	2,137,046	92.3	bluegreen
2	Cocconeis placentula	22	1.4	10,132	0.4	diatom
3	Fragilaria crotonensis	17	1.0	111,015	4.8	diatom
4	Eunotia pectinalis	17	1.0	11,895	0.5	diatom
5	Asterionella formosa	6	0.3	1,211	0.1	diatom
6	Cryptomonas erosa	6	0.3	2,863	0.1	cryptophyte
7	Anabaena planctonica	6	0.3	40,309	1.7	bluegreen
8	Ankistrodesmus falcatus	6	0.3	138	0.0	green

Aphanizomenon flos-aquae cells/mL =	33,921
Aphanizomenon flos-aquae heterocysts/mL =	154
Anabaena planctonica cells/mL =	220
Anabaena planctonica heterocysts/mL =	11
Anabaena planctonica akinetes/mL =	6

Aquatic Analysts **Sample ID:** NB86

Phytoplankton Sample Analysis

Sample:	Tenmile Lake
Sample Site:	N16
Sample Depth:	
Sample Date:	19-Jul-10
Total Density (#/mL):	2,904
Total Biovolume (um^3/mL):	3,864,179
Trophic State Index:	59.6

	Species	Density #/mL	Density Percent	Biovolume um^3/mL	Biovolume Percent	Group
1	Aphanizomenon flos-aquae	2,847	98.0	3,766,875	97.5	bluegreen
2	Fragilaria crotonensis	36	1.2	29,896	0.8	diatom
3	Anabaena planctonica	14	0.5	65,130	1.7	bluegreen
4	Microcystis aeruginosa	7	0.2	2,278	0.1	bluegreen

Aphanizomenon flos-aquae cells/mL =	59,792
Aphanizomenon flos-aquae heterocysts/mL =	349
Anabaena planctonica cells/mL =	356
Anabaena planctonica heterocysts/mL =	14
Microcystis aeruginosa cells/mL =	285

Aquatic Analysts	
Sample ID:	NB87

Oregon Health Division
Drinking water treatment guidance
August 31, 2001

DHS Contact Information:

Harmful Algae Program Coordinator: Laura Boswell at (971) 673 – 0438
If she is not available call the main line for the Office of Environmental Public Health at: (971) 673 – 0440 or
Toll Free: (877) 290 – 6767 and press 0. Ask for Laura Boswell

1. Treatment systems should consist of sand filtration followed by chlorination, followed by activated charcoal filtration. It is essential that sand filtration be done before disinfection to remove as many algal cells as possible without killing or rupturing them.

2. Chlorination systems should be capable of maintaining at least 1 ppm of chlorine residual for at least 20 minutes contact time before the water enters the activated charcoal system.

3. The final step in the process should be effective activated charcoal treatment to remove toxin remaining after the sand filtration and disinfection processes.

4. All treatment equipment used should meet NSF standard 53, and should be adequately sized to treat the maximum amount of water that you use. Treatment equipment needs regular monitoring and servicing to assure that it functions properly.

5. Ideally all water entering your home should be treated as recommended. It is possible to treat only water used in the kitchen, but this increases chances that animals or pets would inadvertently drink untreated water.

As more monitoring is done and toxin levels are measured this advisory may be altered. The advisory is to remain in effect until specifically changed or lifted by county and state health officials.

FACT SHEET

TOXIC *MICROCYSTIS* BLOOMS IN TENMILE LAKES

(information modified from Oregon Health Division Document: Hazards from *Microcystis aeruginosa* in Fresh Water – http://www.ohd.hr.state.or.us/esc/docs/mafact.htm)

➢ What is a toxic bloom of *Microcystis aeruginosa*?

Microcystis aeruginosa is a species of blue-green algae that grows naturally in many surface waters. In most bodies of fresh water and most weather conditions it does not pose a hazard to wildlife or human beings. However, under certain conditions (such as when the water is warm with abundant nutrients) *Microcystis aeruginosa* can grow more rapidly than normal. The result can be excessive numbers of large colonies that form floating masses on the water surface or that are dispersed within the water column. These occurrences are called "algal blooms". *Microcystis aeruginosa* can produce natural toxins (called microcystins) that are very potent, and these toxins are higher in concentration during bloom conditions. The microcystin toxins are produced and contained inside the *Microcystis* cells, and are released to the water when the cells die and disintegrate. Also, since the cells are very small, they can be ingested along with the water. Toxin levels in a water body tend to be higher near shorelines and at the surface of the water where animal and human contact is most likely.

➢ What are the primary toxic effects of these blooms?

The primary toxic effect of microcystins is on the liver. At very high doses, death of liver cells and destruction of blood vessels in the liver can result in serious injury and possibly death. Though less is known about the long-term effects of microcystin toxins, animal studies have shown these toxins can cause chronic liver damage and may promote the formation of liver tumors. These effects are more likely to occur if exposure is frequent over a long period of time.

The levels of toxin necessary to produce immediate or acute illness in humans and animals are much higher than levels that may cause chronic liver injury. Drinking water standards are usually based on chronic effects. Currently, there is no drinking water standard in the U.S. for microcystins. Canada, Australia, and Great Britain have developed a guideline level of 1 microgram toxin per liter of water, or 1 part per billion (1 ppb). During algal blooms, toxin levels can greatly exceed 1 ppb.

➢ How is it determined when the water becomes safe once a bloom is reported?

Changes in weather or in other conditions in a water body influence the growth of blue-green algae. Generally, cooler weather, rainfall, and reduced sunshine will lead to reductions in algal growth and toxin levels. Algal blooms generally peak and die off rapidly and toxin levels in the water decline over days or weeks. Only blue-green algae experts can distinguish visually between different kinds of algal growth, and are able to determine when blooms have disappeared. Testing of the water is the only way to be certain that toxin levels are no longer dangerous.

➢ When does the Oregon Health Division Issue Warnings?

Drinking Water -- When measured or estimated toxin levels reach 1 ug/l the Department of Human Services, Office of Public Health Systems issues public advisories or warnings. These will include warnings regarding the use of water for drinking or food preparation unless the water has been treated following specific guidelines for destroying and removing toxins. Animals should be kept away from water during periods when microcystin toxin levels exceed 1 ug/l, because drinking the water can cause serious or even fatal illness.

Contact Recreation -- If levels are high enough to pose hazards for swimming, water-skiing or other direct skin contact activities, the advisories will warn against water contact. Generally skin hazards occur where the water has a green or blue-green color or where there are visible clumps or mats of algae present in the water. When measured toxin levels reach 5 ug/L or cell counts reach 15,000 cells/ml, contact recreation is considered unsafe.

➢ Can testing ensure that all areas of the lake are safe?

No, due to the patchy nature of blue-green algal blooms it is possible for higher *Microcystis* densities (and therefore higher microcystin toxin concentrations) to be present in areas not sampled in a given survey, particularly along shorelines or during calm conditions of little to no wind. **Therefore, when a lake has a demonstrated history of algal toxicity or the presence of known toxin producing algal species, those utilizing the lake for drinking water should always follow Oregon Health Division recommendations for purification. In addition, recreational users should always avoid contact with water whenever noticeable surface concentrations of algae are evident or when the lake has an obvious green to blue-green appearance.**

➢ Are domestic animals at risk during blooms?

Yes, pets or other domestic animals are the most likely to ingest contaminated water, these animals should not be allowed access to the lakeshore whenever either noticeable surface concentrations of algae or an obvious green to blue-green appearance is evident.

➢ Is it safe to eat fish and other aquatic life?

Clams, mussels, snails and other shellfish should not be eaten during microcystin advisory periods, but it is believed that fish can be safely eaten if they are cleaned and all internal organs discarded. Internal organs of such fish may be toxic even to animals.

➢ How much does testing cost?

Samples must be shipped to qualified laboratories for analysis. A microscopic determination to quantify the number of Microcystis colonies and cells costs $90 per sample. A specialized test to analyze for the microcystin toxin concentration costs $100 per sample (overnight shipping costs not included), and for anatoxins the cost is $250/sample .

- NOTE: A fact sheet about microcystin toxin and its effects may be found on the Web at www.dhs.state.or.us/publichealth/esc/docs/mafact.cfm